

Comparative Study of Immediate Effect of Superficial Heat, Deep Heat and Cryotherapy Prior to Stretching on Plantarflexor Extensibility

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Abstract: *Plantarflexors are essential in gait and postural control, they are key components of injury prevention and rehabilitation in sports. Objective: To verify an immediate effect of Cryotherapy and heat on plantarflexor extensibility prior to stretching and to compare which is more effective in young asymptomatic females. 40 young female participants were taken and divided in 4 groups, 10 in each group and immediate effect was noted. Outcome Measure: ROM. Result: Data analyzed revealed significant increase in ROM in Group which was given Cryotherapy prior to stretching. Conclusion: Cryotherapy prior to stretching has more of an immediate effect compared to superficial heat and Deep heat on plantarflexor extensibility.*

Keywords: Extensibility, Cryotherapy, Superficial and Deep heat, stretching, ROM

1. Introduction

The Plantarflexors of ankle are situated at back of leg (calf). They include Gastrocnemius and Soleus muscles which are inserted into the strongest tendon of body "TENDOACHILIS." Plantarflexion produced by these two, is very essential in walking and running. In walking, soleus overcomes inertia of body weight and when movement is underway, quicker acting gastrocnemius increases the speed of movement.^[7] They play an important role in gait and postural control.^[1] Extensibility is defined as an ability to stretch a muscle tendon unit to its fullest length.^[1] Lack of extensibility in this muscle group may cause decrease in dorsiflexion and can also lead to achilistendinitis, plantar fasciitis, muscle strains, and ligament sprains.^[5] Causes of TA tightness are: Disuse of muscle in its full length during ADLs, Use of high-heeled footwear in girls, Lack of flexibility.^{[1],[5]} Thus, stretching can be used as a part of physical fitness and rehabilitation programs because it is thought to positively influence performance and injury prevention. The goal of stretching is often to change the physical characteristics of connective tissue. Connective tissue is a viscoelastic structure capable of plastic and viscous changes. Stretching protocols produce deformational changes that lengthen connective tissue and increase joint ROM.^[2] The static stretching protocol requires that the stretch being performed should be in a slow, gradual manner and held at end range just before the point that causes discomfort to patient. Static stretching is preferred over ballistic stretching because it is energy efficient, thus requiring less energy to perform than the ballistic stretch, and because the probability of injury may be lower than with ballistic stretch. Therapeutic heat and cold are widely used in clinical application and determines amount of elongation obtained from a stretch. It can be in the form of: Superficial Heat, Deep Heat, and Cryotherapy. It is well documented in studies that as intramuscular temperature increases the extensibility of contractile and non-contractile soft tissue likewise increases. The plastic deformation of tissue, amount of force required and time of stretch force needed to be

applied decrease progressively. There is also a decrease in rate of firing of Type 2 efferents from muscle spindle & increase in GTO sensitivity^{[1],[2]} It is believed that when tissues are relaxed they are easier to lengthen. In relaxed tissues, stretching is associated with less muscle guarding, less damage to tissue while stretching and is comfortable to patient.^{[1],[2]} Superficial heat is applied in the form of hot packs, paraffin, fluidotherapy, IR. Hot packs are commonly used because they are easy to apply and economical.^[6] Deep Heat is applied in the form of Ultrasound (Continuous) with the frequency of 1MHz and at an intensity of 1.0W/cm² for 7 to 8 minutes which will be sufficient to increase tissue temperature.^[6] Cryotherapy reduces discomfort of stretch sensation, diminishes sensitivity to muscle spindle, enhances viscous properties of muscle.^{[6],[1]} It is used in the form of ice packs. Extensibility of muscle is necessary to maintain because for effective muscle action to occur an optimal length tension relationship is required^[6]

2. Methods

The study design was an Experimental study and was conducted in research lab at K.J.Somaiya College of Physiotherapy. 40 young, asymptomatic females (N=40) within the age group of 17-25 years whose ankle dorsiflexion ranges were less than 20 degrees were selected provided that they did not have any history of recent fractures, sprains of lower limb or Varicose Veins. Infections or open wounds, Impaired sensation in lower limb, previous neuromuscular disorder of Hip, Knee or Ankle (In past 2 years), Malignancy of lower limb were all excluded. Candidates who were following any flexibility program were also excluded. Written consents were taken from all the subjects. Simple Random sampling method was done and subjects were divided into four groups: Group A - Static stretching (Control group); Group B- Static stretching + Superficial heat; Group C- Static stretching + Cryotherapy; Group D -Static stretching + Deep heat.

Prior to the treatment, range of ankle dorsiflexion was measured with a universal goniometry using a standard protocol. Subjects were positioned supine on the plinth with knee in extension. For goniometric measurement, stationary arm was placed along the long axis of fibula by using marks on the fibular head and lateral maleolus. Moving arm of the Goniometer was placed parallel to the lateral border of the foot by using marks on base of the head of the fifth metatarsal. [7] Treatment was given immediately after assessment and ROM was measured immediately after treatment and effect will be noted on both the sides. For every Groups Runner's stretch was given prior to treatment.

RUNNER'S STRETCH was given according to 1/3rd of body weight of person. [3],[4],[5] Runner's stretch has an advantage over passive stretching as it is an objective measure to quantify stretch, amount of force given is same throughout the study, Comparison is more reliable and equal, Energy of therapist is conserved, chances of overstretching or understretching is reduced. [2]



The subjects in Group A were told to perform Runner's stretch, subjects were standing approximately 3-4 feet away from the wall with their hands placed flat against the wall at shoulder level with elbows extended. The subjects stepped forward by flexing the left knee and then shifting their body weight forward on left leg. One of the heel remained flat on floor with respective knee in extension, 4 Runner's stretches were performed for 20 second with a 10 second rest period between each stretches. [3],[5]

The subjects in Group B received Superficial heat in the form of hot packs(wrapped in layer of Turkish towel) to plantar flexors on both the side in prone position for 08 minutes prior to performing stretching. [1],[6]

The subjects in Group C were given Cryotherapy in the form of Ice packs to plantar flexors on both the side in prone position for 08 minutes prior to performing stretching. [1],[6]

The subjects in Group D were given Deep Heat in the form of continuous Ultrasound, they were positioned in prone position and continuous ultrasound was given with frequency of 1MHz and an intensity of 1.0W/cm² for 08 minutes on musculotendinous junction of plantarflexors prior to performing stretching. Both the legs were stretched throughout the study. All the measurements of Dorsiflexion were recorded immediately post treatment. [1],[6]

Data was analysed using statistical tests which were performed using Graphpad InStat software (version 3.10) package. For Intragroup comparison as the data passed normality, paired t test was performed and for Intergroup comparison ANOVA was performed.

3. Results

In this study we have taken 40 female subjects with a mean age of 17 to 25 years with AROM range 20 or less than 20 degrees.

Dorsiflexion range was a dependent variable & data was analysed in the group by performing paired t test between pre and post dorsiflexion ROM.

Analysis to compare within the 4 groups (Intragroup Comparison) :

Table 1: Mean and standard deviations of Group A

Group A	Right		Left	
	PRE	POST	PRE	POST
Mean	15.7	16.3	15.5	16.2
SD	3.33	3.26	3.27	3.01
SE	1.055	1.033	1.035	0.9522
MEDIAN	15	15.5	4.5	16

Table 2: Mean and standard deviations of Group B

Group B	Right		Left	
	PRE	POST	PRE	POST
Mean	15	16.7	14.9	16.6
SD	2.30	2.83	2.42	2.91
SE	0.7303	0.8950	0.7667	0.9214
MEDIAN	14.5	15.5	14	15.5

Table 3: Mean and standard deviations of Group C

Group C	Right		Left	
	PRE	POST	PRE	POST
Mean	15.9	21.2	16	21.4
SD	2.51	2.48	2.35	2.22
SE	0.7951	0.7860	0.7454	0.7024
MEDIAN	15.5	21	16.5	21.5

Table 4: Mean and standard deviations of Group D

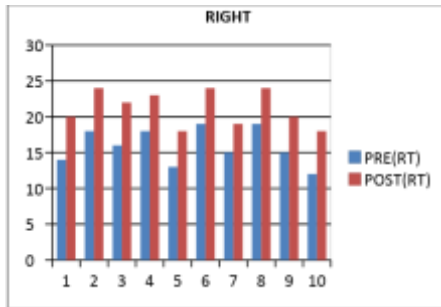
GROUP D	RIGHT		LEFT	
	PRE	POST	PRE	POST
MEAN	14.3	17.9	14.3	17.8
SD	2.11	2.23	2.11	2.20
SE	0.6675	0.7063	0.6675	0.6960
MEDIAN	13.5	17	13.5	17

Table 5: p values of Group A,B,C and D (Intragroup comparison with paired t test)

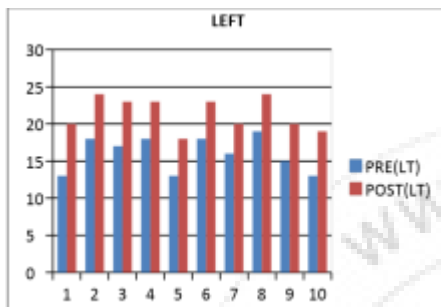
	P values	
	RIGHT	LEFT
GROUP A	0.0051	0.0095
GROUP B	0.0003	0.0001
GROUP C	0.0351	0.0351
GROUP D	0.0002	0.0030

All the four groups had significant difference in pre test and post test values. Paired t test shows that there was statistically significant improvement in ADFROM in all four groups (p<0.05). From all the above tables it is noted that amongst Group A, B, C and D, there is a significant increase in range of Dorsiflexion uniformly in all the groups but the measurements of range of Dorsiflexion shows a significant and maximum increase in Group C as it shows maximum Mean values which is followed by Group D and no or

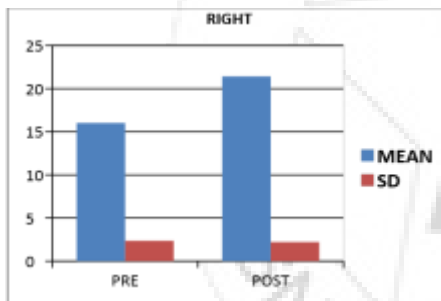
minimal change noticed in Group A and B as Mean values noted in Group B and Group A is least.



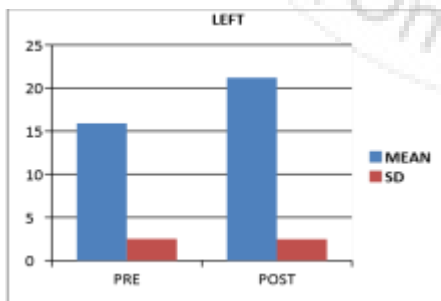
Graph 1: Comparison of pre and post ROM in Group C (right side)



Graph 2: Comparison of pre and post ROM in Group C (Left side)



Graph 3: Comparison of pre and post Mean,SD values in Group C(Right side)



Graph 4: Comparison of pre and post Mean,SD values in Group C (Left side)

From the above Graph (1,2,3,4) It is concluded that Group C shows maximum increase in ADROM

Analysis to compare in between the 4 Groups (Intergroup Comparison) :

Comparisons were carried out by performing one-way ANOVA. It was found that p values were < 0.05 for both the sides, which was considered extremely significant.

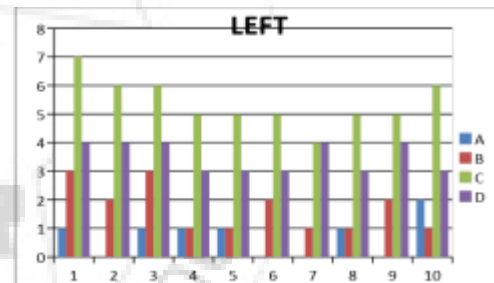
Table 6: Sum and Mean of ranks of all the groups (Right side)

Groups (Right)	Number of subject	Sum of ranks	Mean of ranks
A	10	73	7.3
B	10	141	14.1
C	10	352	35.2
D	10	254	25.4

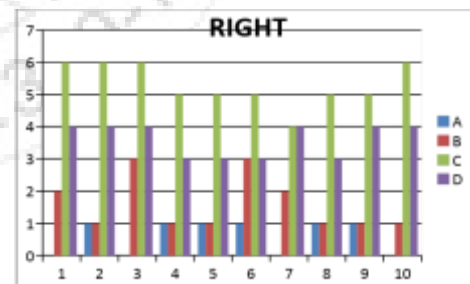
Table 7: Sum and Mean of ranks of all the groups (Left side)

Groups (Left)	Number of subject	Sum of ranks	Mean of ranks
A	10	74	7.4
B	10	141	14.1
C	10	352	35.2
D	10	252	25.2

The results presented in the table 6 and 7 shows that, according to sum or the mean of ranks, Group C is the most effective treatment intervention of choice which can be given as an immediate treatment to patient, followed by Group D which is less effective as an immediate treatment than Group C but can be used on a secondary basis as an immediate treatment intervention of choice i.e. Ultrasound. Superficial heat and stretching alone has less immediate effects on plantarflexor extensibility amongst other treatment modality.

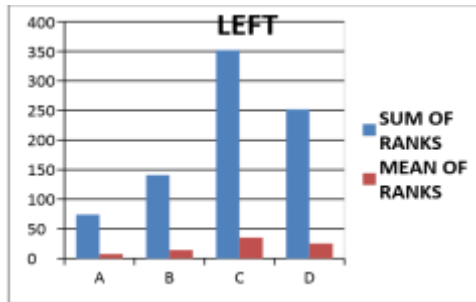


Graph 5: Difference between pre and post treatment ROM

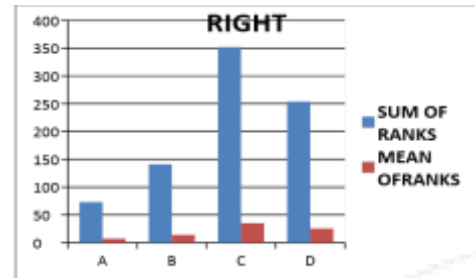


Graph 6: Difference between pre and post treatment ROM

Graph 5 and 6 shows intergroup comparison of difference in ROM post treatment which shows that Group C has maximum increase in Dorsiflexion.ROM



Graph 7: Comparison of Sum and Mean of Ranks



Graph 8: Comparison of Sum and Mean of Ranks

Graph 7 and 8 shows comparison of Sum of Ranks and Mean of Ranks between all 4 groups on both sides. It shows that group C has maximum Sum and Mean of Ranks amongst other groups.

4. Discussion

This study documented effects of Superficial heat, Deep heat and Cryotherapy prior to static stretching for improvement of plantar flexor extensibility limited by soft tissue tightness in healthy females. Many studies have proved that stretching, as always, has a significant increase in improving the muscle extensibility^[1]. Keeping that in mind, our study was done only to find out immediate effect of which therapeutic agent i.e. Superficial heat (hot packs), Cryotherapy (Ice packs), Deep heat (Ultrasound) prior to the stretching is effective in improving plantarflexor extensibility. The result of the study shows that Cryotherapy prior to stretching causes significant increase in extensibility of plantarflexors and thus, increases in ADROM.

According to the intervention done, Cryotherapy is the best choice of treatment prior to stretching to have an immediate effect as compared to superficial heat and deep heat in increasing range of dorsiflexion. Application of therapeutic agent prior to the stretch performed reduces discomfort to stretching maneuvers.^{[1], [2]}

Cryotherapy allows muscle to relax and be stretched more fully during stretching^[3]. According to William Prentice Cryotherapy increases the muscle's elasticity and hence slows down the muscles ability to contract and avoid spasm^[3]. Also application of Cryotherapy to stretched causes depression of stretch reflex^[3].

Bell et al found that stretching combined with Cryotherapy showed reduced T- reflex.^{[1], [3]}

It is postulated that the Cryotherapy causes direct sensory stimulation of primary and secondary muscle spindle

afferent fibers and thus indirect reflex inhibition, which then decreases γ -activity and lowers muscle's threshold to interfere in muscle excitability^{[7], [1]}. Used in the form of Ice packs delivered continuously for 8 minutes diminishes sensitivity to muscle spindle and enhances elastic properties of muscle^{[6], [7]}.

According to Knight, ice treatment if done prior to with stretching, subjects may find it easier to endure the mild discomfort commonly felt at the terminal position of stretch which allows the muscle to be stretched more completely.^{[1], [3]} the findings of this study are in accordance with Minton who stated that Cryotherapy significantly improved dorsiflexion ROM.^{[1], [3]}

Hot packs when applied to Calf muscles, increases the tissue temperature, and makes the muscles more relaxed and comfortable for stretching. In addition, it decreases rate of Type 2 efferents, increases the sensitivity of GTO, and thus reduces muscle tension^[6].

Ultrasound has an ability to elevate tissue temperature to depth of 5cm or more and the temperature increase is associated with an increase in collagen extensibility but according to other studies it is stated that Ultrasound has its effect after long term treatment application (usually 3-4 weeks)^{[2], [6]}. All 3 treatment intervention has significant effect on plantarflexor extensibility prior to stretching but Cryotherapy shows the most immediate increase in ROM followed by Deep heat other interventions performed.

Clinical implication

Based on the results of the present study, immediate effect of Cryotherapy prior to stretching showed maximum increase in dorsiflexion ROM in normal asymptomatic females. These results suggest that an athlete may select Cryotherapy modalities for the purpose of optimizing the effects of stretching. However, the choice should depend on condition surrounding tissues as well as individual preference for ice. This study will allow clinicians the choice of cost effective and easily available treatment alternative. Hence, this can be used as a part of physical fitness and rehabilitation programs because it is thought to positively influence performance and injury prevention.

5. Conclusion

All the four groups showed increase in extensibility of plantar flexors, resulting in increase in ADROM. Cryotherapy prior to stretching (Runner's stretch) has more immediate effect than Superficial heat (Hot packs); Deep heat (Ultrasound) on plantarflexor extensibility and thus the Alternative hypothesis stands true.

6. Future Scope

Can be done on large sample size, on different age groups and this study can be used as a part of physical fitness and rehabilitation programs.

7. Abbreviations

ADROM: Active dorsiflexion Range of Motion
ROM: Range Of Motion

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